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(54) Apparatus for Soft Braking of Moving Parts

Claims

1. Apparatus for braking down motor-driven masses in preferably longitudinal motion by shifting the motor from speed mode to brake mode, **characterized** by a power transistor arranged in the brake circuit, acted upon as a function of the speed of

the motor by a number of pulses variable by timing during the braking operation and variable in pulse width.

2. Apparatus according to claim 1, characterized in that the timing sequence is set as a function of an actual/target comparison between the motor voltage present at each tapping time with the idling voltage set on a potentiometer, the timing sequence being set by means of a microprocessor.

3. Method of braking down according to claim 1 or 2, characterized in that the power transistor at first, at the beginning of the braking operation, is controlled at high generator output of the drive motor at a low pulse frequency, and with an increasing pulse frequency in the course of the braking operation.

4. Method of braking down according to claim 3, characterized in that the power transistor at first, at the beginning of the braking operation, is controlled at high generator output of the drive motor with pulses of narrow width, and in the course of the braking operation with increasing pulse width.

5. Method according to claim 3 or 4, characterized in that the increase in pulse frequency is linear.

Apparatus for Soft Braking of Moving Parts

The invention relates to an apparatus for soft braking of moving parts, in particular heavy parts such as carriages and machine tools, in which both the acceleration and the braking is to take place over a short travel.

Such a problem arises for example for machine tools such as saws in sawmills, or grinding machines, where the carriage is guided along a piece of work, and is to reach optimum processing speed after as short a travel as possible, and likewise over as short a travel as possible, be braked down again and switched into reverse. Here, the braking down must be soft, particularly to avoid concussions on the mechanical parts such as for example the gearing, since such concussions will lead to premature wear. Besides, in such applications the thermal loading of the drive motor or motors and the associated elastic parts must be kept low. To operate such an apparatus without mechanical brakes, the desired acceleration and braking are accomplished by means of the motor. This may mean one or more motors; thus for braking, a special brake motor may be employed.

In the known methods, for braking, the motor, instead of the available speed voltage, i.e. the voltage required to operate the driven part during service at higher speed, is subjected to the idling voltage, at which the motor is operated until it runs down (or until reversal), which is suitably low. To prevent the motor and with it the driven part from running down over a very long distance, in the known methods a relay or a thyristor serves to short-circuit the armature current of the DC motor by way of a brake resistance. In this way, the armature, then acting as generator, is very quickly

braked down to creeping voltage, and will run on slowly under this creeping voltage until it shuts off.

However, this known braking down by means of the drive motor has the disadvantage that with applied creeping voltage, the brake resistance is impressed with the idling voltage until braked down completely, and consequently becomes very hot, which leads to a high unnecessary energy consumption by the time it is shut down. The energy consumption becomes higher still, and the thermal load on components is increased, because the idling voltage, owing to the voltage divider between motor and brake resistance, must be higher. Another disadvantage is the abrupt action of the brake. This moreover unduly loads the mechanical motor parts. A simple shutdown of the speed mode before braking is not a satisfactory solution, since it is then not possible to continue in creeping mode.

The object of the invention, then, is to specify an apparatus for soft, jerkless braking of moving parts, avoiding the disadvantages shown and showing a braking characteristic similar to that of a braking by means of a four-quadrant drive.

This object is accomplished by arranging a power transistor in the brake circuit of a direct-current motor constituting the drive, where the transistor is not operated in the active range, but is tackled. In this way, with the apparatus according to the invention, simple commercial transistors may be used, whereas in the case of operations in the active range, a behavior corresponding to the timing is obtainable only by use of very costly high-power transistors in combination with a controlling RC or LC component.

For with this apparatus according to the invention, very high currents, such as are required to move great masses in the case of sawing machines or machine tools,

can be switched and the drive motor braked down. In order to render the braking especially soft, a controllable timer is arranged in the circuit, with which the pulse frequency can be varied, so that in braking down, the braking can be done first with a small number of pulses, preferably 50, and then increasing to the conclusion of the braking operation with a large number of pulses, preferably 1000.

Here it has been found expedient, in addition to the pulse sequence per unit time, to vary the pulse width as well, i.e. the duration of effectiveness of the pulses. By known means, the pulse sequence and/or the pulse width can be so varied that a braking action from 0 to nearly 100% can be set.

In order to render this braking — which, according to the setting once selected, proceeds uninfluenced — adjustable as well, after an actual/target comparison of the motor voltage present at any arbitrary point in time with the idling voltage set by means of a potentiometer for the individual braking operation, the timing sequence (pulse frequency and/or pulse width) is so varied by means of a regulating element that a continuously acting, and hence soft, braking is assured.

Fig. 1 represents a braking process with different braking down speeds. The curve a, after the speed mode has been shut off, shows first a stronger and then in harmonic transition, a slower braking; curve b shows a linear braking operation, and curve c an at first slower and then faster braking operation.

Fig. 2, finally, shows a block diagram of the circuit, with the target value put in by way of an integrator. A regulator regulates the braking so selected as a function of the actual/target comparison by a microprocessor.

[Fig. 2:]

LINEARES ODER DIGITALES SIGNAL

linear or digital signal

INTEGRATOR

integrator

SOLL-WERT

target value

IST-WERT

actual value

REGLER

regulator

LOGIK LINEAR DIGITAL

logic, linear, digital

LEISTUNGS-TEIL

power part

BREMSE

brake